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Investigation of Plasma Visfatin Changes in Women with Type 2 Diabetes followed by Endurance, Resistance and Combined Exercise: The Role of Lipid Profile, Glycemic Indices and Insulin Resistance

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Abstract

Background and purpose: Visfatin is one of insulin-like proteins secreted by adipose tissue associated with obesity and insulin resistance, but the effect of exercise on the levels of this hormone is unclear, despite various studies in this area. The aim of this study was to compare the effects of aerobic, resistance and combined exercises (strength-aerobic) on visfatin changes, glycemic and lipid parameters and evaluation of relationship between visfatin and insulin resistance in women with Diabetes Mellitus Type 2 (DMT2). The recent study differs with other studies in terms of exercise type, sample size, type of subjects and results.

Materials and Methods: Forty women with DMT2 were selected by purposive sampling method based on availability then randomly divided into four equal groups; three patient (training) groups including aerobic exercise group (20-50 min/day, with an intensity of 60 to 80% of maximum heart rate), resistance group (3 sets, 10 reps, with an intensity of 50 to 65% of one repetition maximum), combined group (with the same intensity and duration of exercises in aerobic and resistance groups) and no-training group as control group. All patient groups participated in 12-week training program for three sessions per week. Fasting blood samples were collected to evaluate of plasma visfatin levels, insulin, glycated hemoglobin, glucose, cholesterol (Cho), triglycerides, HDL and LDL. To calculate the insulin resistance index HOMA-IR equation was used. Data analysis was performed using two-way ANOVA, Kolmogorov- Smirnov test, Levene's test, multiple linear regressions and post hoc Tukey test.

Results: Data analysis showed that the weight index was decreased in aerobic group compared with resistance group. Body fat percentage in combined group was significantly lower than aerobic group and also in aerobic group as compared with control and resistance groups. Waist-to-hip ratio was decreased in aerobic group than combined group. Markers of insulin and insulin resistance reduced in resistance group compared with aerobic and combined groups. LDL index were significantly lower in combined group compared with the resistance and also Cho in resistance group as compared with aerobic and combined groups. There were no significant differences between mean changes of Hb A1c and mean visfatin changes in 4 groups.

Conclusions: Even though in the present study; no significant differences were observed in mean changes of Hb A1c and PVL among groups, but each type of exercises had a positive impact on certain parameters in experimental groups. Longitudinal studies with more participants are needed for evaluation of relationship between visfatin and insulin resistance in women with DMT2.

Keywords: Exercise; Visfatin; Glycemic index; Lipid profile; Women with type 2 diabetes

Introduction

Excess energy intake relative to energy expenditure can lead to obesity and excessive fat accumulation in the adipose tissue [1]. Thereby, the adjustment of energy balance can reduce a significant amount of weight. Obesity and lipid accumulation especially in visceral depots are important risk factors for the development of Diabetes Mellitus Type 2 (DMT2), dyslipidemia, hypertension, and cardiovascular diseases [1-4].

Adipose tissue as an active metabolic endocrine organ discharges a large number of proteins that are collectively referred to as adipocytokines that are most likely to mediate the interaction between adiposity, glucose dysregulation and atherosclerosis improvement [3]. One of the adipokines is visfatin; the gene encoding visfatin is located on the long arm of chromosome 7 and encodes a polypeptide of 491 amino acids with a molecular mass of 52 kDa [5]. This hormone associated with a wide range of biologic effects, including glucose and lipid metabolism that has been involved in the pathogenesis of diabetes and obesity. Many evidences indicate that visfatin plays an important role in glucose homeostasis [6,4]. It has been shown that visfatin binds up to the insulin receptor at a distinct site, and applies its hypoglycemic activity by reducing glucose release from hepatocytes, and stimulating glucose utilization in peripheral tissues [7]. A recent meta-analysis showed that plasma visfatin level (PVL) was increased in patients with obesity, DMT2, metabolic syndrome and cardiovascular disease [8].

Epidemiological studies confirm that physical activity like regular exercise is related to the decreased incidence of DMT2 [9-12]. Also

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several studies have demonstrated that exercise alone has clinical benefits, such as improving insulin sensitivity, reducing glycated hemoglobin (A1c) and increasing peak oxygen consumption (VO_2 peak) [13-15].

While the effects of physical activity and exercise on PVL have been studied among various forms of human and animal samples [13-17] but their results are inconsistent. Bo et al. found that after one year lifestyle modification, including diet and exercise, PVL did not change [18]. In other study PVL among diabetic patients were same after 12 weeks of aerobic, resistance and combined exercises [19]. In contrast, one study has shown that exercise training with weight loss induced a significant reduction of PVL in non-diabetic Korean women [20]. Another research among obese females reported that PVL reduced after 12 weeks of combined training (aerobic-strength), this reduction was associated with a decrease in anthropometric variables and blood glucose levels [21]. Because of conflicting studies about the effect of exercise on PVL, especially in obese and diabetic people, we aimed to compare the effects of aerobic, resistance and combined exercises (strength-aerobic) on visfatin changes, glycemic and lipid parameters and also to evaluate relationship between visfatin and insulin resistance (IR) in obese women with DMT2.

Materials and Methods

Study design, setting and sampling

This study was performed in Urmia, the capital of West Azarbayjan province, located in north-western of Iran. We used purposive sampling method based on availability among obese women with DMT2 who referred to one of endocrinology clinic affiliated to Urmia University of Medical Sciences.

Participants

Study subjects consisted of 40 diabetic untrained obese women who were randomly divided into four equal groups –10 participants in each–; three patient (training) groups (aerobic, resistance and combined) and one control (no-training) group. Inclusion criteria included having fasting blood sugar more than 126 mg/dl - according to World Health Organization (WHO) criteria [22] for at least six months, lack of a history of physical activity, weight fluctuations amounting to 10% of own weight. It should be noted that, all subjects were taking metformin three times a day during the last 6 months and during the study. Exclusion criteria included insulin therapy, acute or chronic disease (high blood pressure, cardio –vascular, hormonal, kidney, liver) and any intervention that affecting the experimental results.

Laboratory investigations

For all participants were explained that our aim is not weight loss due to a regimen. So they should not alter their diet as directed by their doctor. It was described that we attempt about the effects of exercises. All subjects complete Physical Activity Readiness Questionnaire (PAR–Q) which is a safe preliminary screening of candidates for exercise testing and prescription [23]. The study continued with the following phases:

Screening sessions: Before each phase informed consent was obtained, blood glucose, blood pressure, resting heart rate and medical history were assessed and recorded. For each participant, the systolic and diastolic blood pressure was taken using a standard zero mercury sphygmomanometer after at least 10–15 minutes of rest. If the pre-exercise blood pressure was less than 140/90 mm hg, subject could begin exercise. If the pre-exercise blood pressure was greater than or equal to 140/90 mm hg, she was asked for 10 minute break and re-evaluate their blood pressure. With an uncontrolled hypertension, intervention had not been done on that day. If the subjects had low blood glucose levels (less than 100 mg/dl), they had to consume the syrup contains about 15 grams of carbohydrates. If they had high blood glucose levels (greater than 300 mg/dl), they had to control their blood glucose level by exercise within 20 to 30 minutes. Pointed out that, all variables relevant to the parameters were measured 2 days before, and 2 days after the study.

Measuring anthropometric indicators: Body mass index (BMI) calculated based on anthropometric scales; by the ratio of weight (kilogram) to the square of height (meters). Fat distribution measured by waist circumference (WC), hip circumference and Waist to Hip ratio (WHR). Waist circumference was measured in centimeters at the region of the trunk that is midway between the lower costal margin (bottom of the lower rib) and the iliac crest (top of the pelvic bone) by using non stretchable measuring tape. Moreover, the hip circumference of each subject was measured in centimeters using the same measuring tape at its widest portion of the buttocks. Their Waist to Hip ratio (WHR) was also calculated by taking the waist circumference (cm) and dividing by the hip circumference (cm). Body Fat percentage (BF%) for each women was calculated using the skinfold caliper– it is a device which measures the thickness of a fold of skin with its underlying layer of fat. In this study caliper RH.15.9LB model, made in Germany, was used in three-point method (the back of the upper arm or triceps, abdomen and suprailiac) and then the sum of skinfolds implanted in the general equation of Jackson and Pollock for determining BF% in women [24].

Measuring of hematologic parameters: Fasting blood samples were collected in two stages; pre-test and post-test (two days before and two days after completion of 12 weeks of exercise). The sample consisted of 7 ml of antecubital venous blood that was taken between the hours of 7 to 10 am following an overnight fast. The subjects were asked to avoid performing any hard exercise during the 48 hours before both stages of blood sampling. Fasting insulin levels are obtained by Electrochemiluminescence method using Elecsys 2010 equipment (Roche Kit). Glucose levels were measured by enzymatic method in the Integra 400 device kits manufactured by Roche Company. Also measurement of low Density Lipoprotein (LDL), High Density Lipoprotein (HDL), Triglyceride (TG), Cholesterol (Cho) indicators was performed by enzymatic method on a Roche Cobas Integra 400 analyzer. Visfatin concentration was measured by ELISA method using Human visfatin Elisa Kit, BT made in China, Catalog Number E0025Hu and the coefficient of variation within group CV>10% and between-group CV>12%. Hemoglobin Glycosylated A1c was measured by Electrochemiluminescence method using kit Roche. Homeostatic model assessment of insulin resistance (HOMA-IR) was calculated to assess the insulin resistance according to the formula given below [25].

HOMA-IR=fasting glucose (mmol/l)×fasting insulin (μU/ml)/22.5

Training protocol–Participants in the aerobic exercise group performed impulse PT300 treadmill walking/running exercise; 3 times/week for 12 weeks. In order to determine exercise intensity; maximum heart rate (HR max) for each subject was calculated using the formula; "age-220" [26].

Program for aerobic exercise participants included 10 minute warm-up, exercises with intensity of 40-50% of HR max for 20 minutes then with the progress of the training program gradually increased to

70-80% of HR max for 45-50 min. Exercise intensity was measured using stethoscope Polar (Polar, S810, Kempele, Finland) to ensure compliance activity.

To learn the correct exercises; program for resistance exercise participants was begun one day earlier. In their first training session; for each of the exercises one repetition maximum (RM 1) was estimated according to the following formula [27]:

Weight×{1+(30/number of reps)}=RM 1

Resistance exercise participants performed 9 power moves as 3 sets with 10 repetitions, rest periods between sets was considered 60-90 seconds. Each resistance session was 1 hour consists of 10 minutes of warming up, 40-45 minutes of main training and 5 minutes of cooling-down. Every two weeks work load (RM 1) was recalculated to observe the principle of over load and increase the intensity, thus the first four weeks, with 40-45% of RM 1, the second four weeks with 50-55% of RM 1 and the last four weeks, with 60-65% of one RM 1. Resistance training included 4-motion for upper body muscles: bench press, shoulder press, standing cable curl with rope and rope press down and 3 motion for lower body muscles: leg press, leg extension and leg flexion and the two movements for anterior muscles, abdominal and back extension.

Combined training program included all programs of aerobic and resistance exercises with the same intensity, duration and time. Their program composed two sessions of aerobic exercise and one resistance training session during the first two weeks and within the second two weeks; two sessions of resistance training and one aerobic training session. The program was repeated intermittently for 12 weeks.

Ethical considerations

Our research approved by the ethics committee of Urmia University of Medical Sciences. All of the participants were briefed on the study objectives and related sports activities. Subjects were informed that their participation was voluntary. Indeed participants provided their written informed consent to participate in this study and and emphasized that they could refuse participation or leave the study at any, and thus would not adversely affect treatment or care provided by their endocrinology clinic.

Statistical analysis

All the descriptive data were expressed in terms of mean ± standard error of the mean (SEM). Kolmogorov- Smirnov test (KS test) and Levene's test were used for the detection of normal distribution of data and homogeneity of variance, respectively. One-way ANOVA test was used to examine group differences in the various parameters in the base line and two-way ANOVA and Tukey test was used to compare parameter changes between intervention groups. To evaluate the correlation between visfatin changes and physiological variables and body composition in two pre-test and post-test situations multiple linear regression method was used. All data was analyzed using an SPSS version 21 with statistical significance set at an alpha level of ≤0.05.

Results

Of 40 study subjects, seven women were excluded; one subject from the aerobic group because of an illness unrelated to this study, four subjects from resistance and combined groups due to non-participation in training program, two subjects in the control group because they did not participate for the blood sampling test in the second phase (post-test). Finally the results analysis was performed with 33 subjects. The subjects' characteristics did not significantly differ between the groups at the baseline (P>0.05) (Table 1). Table 2 illustrated the mean values of anthropometric, physiological and biological parameters of four groups, before and after the intervention.

Analyze of anthropometric variables by two-way ANOVA test showed that, the mean changes in weight in the aerobic exercise group compared with the resistance group were significantly decreased (change=-7.98; p=0.044). Mean changes in BF% in combined group was significantly lower than aerobic group (change=-7.24; p<0.001). Also BF% was significantly decreased in aerobic group as compared with control (change=- 4.66; P=0.01) and resistance groups (change=-7.72; p<0.001). Mean changes in WHR index in the aerobic exercise group compared to the combined group (change=-0.074; p=0 .012) were significantly decreased (Table 3).

Analyze of glycemic indicators showed that, the mean changes of insulin among the resistance group were significantly decreased compared to the aerobic exercise group (change=-2.52; p=0.012). Besides the mean changes of IR were significantly decreased in the resistance group compared to the aerobic group (change=-4.29; p<0.001) and to the combined group (change=-2.97; p=0.029) (Table 3).

About lipid profile parameters; the mean changes of LDL in the combined group were significantly lower than resistance group (change=-26.1; p=0.043). Mean changes of Cho index in the resistance group compared to the aerobic group (change=-29.3; p=0.04) and the combined group (change=-30.1; p=0.04) were significantly decreased. It should be noted that, two-way ANOVA indicated no significant differences in the mean changes of BMI, HbA1c, fasting glucose, TG, HDL and finally visfatin between four groups (Table 3).

On multiple regression analysis; among physiological parameters as independent variables only two indices; LDL and Cho were predictors of visfatin levels as dependent variable of this study. So that; with 1-unit increase in the amount of LDL in the basic condition, visfatin level was increased to 0.390 units. While in post-test phase this value was converted to 0.338 units. Moreover with every unit increases of Cho in the basic condition, visfatin levels were increased to 0.314 units whereas in post-test phase this level was changed to 0.243 units (Table 4).

Variable	Control	Aerobic	Resistance	Combined	P value
Age(year)	61.25 ± 1.77	58.33 ± 1.81	57.12 ± 1.79	56.5 ± 1.87	0.291
Height(m)	156.5 ± 2.69	154.6 ± 1.57	158.9 ± 1.74	158.6 ± 0.65	0.300
Weight(kg)	77.62 ± 3.00	75.66 ± 3.67	83.56 ± 3.06	79.68 ± 2.17	0.321
BMI(kg/m²)	31.71 ± 0.69	31.73 ± 1.60	33.25 ± 1.19	31.77 ± 0.89	0.755
Body fat %	39.48 ± 1.86	36.33 ± 1.79	43.08 ± 1.14	43.81 ± 0.93	0.552
WHR	0.87 ± 0.02	0.89 ± 0.02	0.87 ± 0.01	0.92 ± 0.02	0.440
HbA1c	7.63 ± 0.26	7.94 ± 0.31	8.80 ± 0.63	8.07 ± 0.05	0.361
Time since diagnosis(year)	7.25 ± 1.34	6.88 ± 1.07	9.12 ± 1.27	8.00 ± 1.46	0.341

Table 1: Subjects' characteristics at baseline [mean ± standard error of the mean (SEM)].

Group	Control		Aerobic		Resistance		Combined	
Variable	Pre	Post	Pre	post	Pre	post	Pre	post
Weight(kg)	77.62 ± 3.00	77.95 ± 3.11	75.66 ± 3.67	73.52 ± 3.48	83.56 ± 3.06	81.58 ± 2.40	79.68 ± 2.17	76.27 ± 2.27
BMI(kg/m^2)	31.71 ± 0.69	31.84 ± 0.74	31.73 ± 1.60	30.84 ± 1.53	33.25 ± 1.19	32.55 ± 0.98	31.77 ± 0.89	30.40 ± 0.89
Body Fat (%)	39.48 ± 1.86	40.43 ± 1.42	36.33 ± 1.79	34.25 ± 1.78	43.08 ± 1.14	42.95 ± 1.19	43.81 ± 0.93	41.26 ± 1.09
WHR	0.87 ± 0.02	0.88 ± 0.01	0.89 ± 0.02	0.82 ± 0.02	0.87 ± 0.01	0.88 ± 0.01	0.92 ± 0.02	0.94 ± 0.02
Hb A1c (%)	7.63 ± 0.26	7.57 ± 0.31	7.94 ± 0.40	7.03 ± 0.43	8.80 ± 0.63	7.73 ± 0.48	8.07 ± 0.50	6.70 ± 0.29
FBG(mg/dl)	136.12 ± 9.63	146.12 ± 4.32	144.88 ± 13.19	105.55 ± 7.73	178.75 ± 19.13	124.12 ± 14.86	155.87 ± 11.12	117.25 ± 6.01
Insulin(µIU/ml)	7.86 ± 0.67	6.88 ± 0.67	6.09 ± 0.80	6.04 ± 0.64	9.09 ± 0.70	8.09 ± 0.64	7.04 ± 1.18	6.82 ± 0.95
IR (HOMA-IR)	8.48 ± 0.95	8.00 ± 0.73	7.00 ± 1.12	5.06 ± 0.64	12.65 ± 1.33	8.02 ± 1.23	8.44 ± 1.21	6.28 ± 0.77
TG(mg/dl)	166.50 ± 24.77	168.00 ± 24.69	166.88 ± 22.76	111.11 ± 10.87	212.75 ± 30.66	146.00 ± 24.58	138.12 ± 24.87	102.00 ± 16.93
HDL(mg/dl)	50.41 ± 3.24	49.60 ± 2.61	52.66 ± 2.81	60.43 ± 2.12	52.87 ± 5.19	53.91 ± 3.92	52.47 ± 2.11	59.95 ± 1.21
LDL(mg/dl)	111.25 ± 9.79	117.71 ± 9.63	110.78 ± 4.51	91.24 ± 3.92	126.87 ± 12.00	114.46 ± 10.36	101.58 ± 12.57	87.55 ± 11.22
CHOL(mg/dl)	190.00 ± 12.05	189.50 ± 9.61	180.77 ± 3.19	146.33 ± 3.05	214.62 ± 14.17	171.12 ± 7.89	180.75 ± 16.99	144.62 ± 13.91
Visfatin(ng/ml)	20.24 ± 2.37	21.90 ± 2.53	25.76 ± 5.18	15.35 ± 1.35	18.67 ± 1.25	24.94 ± 4.71	21.61 ± 2.66	15.80 ± 1.88

Table 2: Values of biochemical and anthropometric parameters (mean ± SEM).

Group Variable	Control			Aerobic		Resistance
	Aerobic	Resistance	Combined	Resistance	Combined	Combined
Weight(kg)	3.19	-4.78	-0.19	-7.98*	-3.38	4.59
BMI(kg/m^2)	0.49	-1.12	0.69	-1.61	0.19	1.81
Body Fat%	4.66*	-3.05	-2.57	-7.72*	-7.24*	0.48
WHR	0.01	-0.06	-0.05	-0.01	-0.07*	-0.05
HbA1c	0.10	-0.67	0.20	-0.77	0.10	0.88
FBG(mg/dl)	15.9	-10.3	4.56	-26.2	-11.3	14.8
Insulin(µIU/ml)	1.30	-1.21	0.44	-2.52*	-0.86	1.66
IR (HOMA)	2.20	-2.09	0.88	-4.29*	-1.32	2.97*
TG(mg/dl)	28.2	-12.1	47.1	-40.3	18.9	59.3
HDL(mg/dl)	-6.54	-3.38	-6.20	3.15	0.33	-2.81
LDL(mg/dl)	13.4	-6.18	19.9	-19.6	6.44	26.1
CHOL(mg/dl)	26.1	-3.12	27.0	-29.3*	0.86	30.1*
Visfatin(ng/ml)	0.51	-0.73	2.3	-1.24	1.84	3.09

Table 3: Difference changes between pre-test and post-test results of Tukey test (0.05>α).

Discussion

Most proteins that are secreted by adipose tissue leads to increased IR because they have direct effect on lipid, glucose metabolism and insulin action. Although all of these proteins are not cause diabetes, even some of them play a protective role against IR and diabetes [28]. Visfatin is one of adipocytokines which is mainly secreted from visceral adipose tissue. Different studies showed a direct relationship between PVL, obesity and DMT2 [29-32]. The positive effects of regular aerobic and resistance exercise in DMT2 patients is well established- included improving glycemic control, improving lipid profile indices and decreasing diabetic complications [33-37]. But there are contradictory studies about the effect of exercise on PVL. Therefore we aimed to compare the effects of aerobic, resistance and combined exercises on PVL, glycemic and lipid parameters and also to assess relationship between PVL and IR in obese women with DMT2 (Table 5). Our results of comparing the impact of three types of study exercises on body composition parameters in women with DMT2 are described below.

On body composition

Participants in aerobic exercise group had more improvement than resistance training participants in weight, BF% and WHR indices. Moreover, the combined exercise training (aerobic-resistance) was more effective than the aerobic exercise in the improvement of BF%. In contrast to our study, Cuff et al. did not report any significant differences in terms of weight loss among two aerobic and resistance groups with DMT2 [38]. While Marcus et al. expressed more reduction in weight and BMI was observed among combined group compared to the aerobic group. They also pointed out that the combined exercise made a greater increase in muscle mass compared to each of the exercises [39].

On glycemic indices

Like insulin, muscle contraction increases membrane permeability to glucose due to an increase in glucose transporter type 4. Thus, the physical activity can reduce glycated hemoglobin levels [40]. The level of Hb A1c less than 7% reduce risk of cardiovascular diseases up to 76% [41]. In our study, Hb A1c was reduced to 0.91% in the aerobic exercise group, 1.0% in the resistance group and 1.36% in the combined training group (Table 2). The mean value of Hb A1c between four groups was approximately 8.11%. However, because the mean changes between groups were similar, no significant differences were observed between them. This finding is in agreement with the results of Jorge et al. who indicated no significant difference of Hb A1c followed the implementation of three months aerobic-resistance and combination exercises [19]. In contrast, a Meta-analysis study among diabetic subjects has been reported a significant reduction in HbA1c after the implementation of aerobic, resistance, and combined exercises. Also they reported that exercise were more effective among patients who their baseline Hb A1c were more than 7% than who had lower A1c [42]. It seems that, in our study the low number of participants, long-term exercise and fairly good basic metabolic control participants are important factors for non-significant changes in Hb A1c.

	Coefficients(B)		Sig.
Constant	**Pre** test	37.89	0.001
	Post test	33.68	0.001
LDL	**Pre** test	0.390	0.026
	Post test	0.338	0.047
Cho	**Pre** test	0.314	0.023
	Post test	0.243	0.043

Table 4: Multivariable regression analysis of visfatin and lipid profile parameters at baseline and post-test.

Studies	Duration, Intensity	Type of exercise	Sample Size	Type of Subject	Sex	Age (years)	Results
Ya Gao et al. [17]	6 weeks	swimming	40 subjects	rats	-	-	Visfatin decreased
Jorg et al. [19]	12 weeks(60 minutes, 3 days per week)	Aerobic(cycling) Resistance Combined(Aerobic-Resistance)	48 subjects	Human	Female/male	53.9 ± 9.9	Visfatin increased
Seo et al. [21]	12 weeks (1 hour, 3 days per week)	Combined(Aerobic(60-70% of their heart rate reserve (HRR))-Resistance 3 sets of 10 repetition maximum (10RM)	20 subjects	Human	Female	39.8 ± 5.3	Visfatin decreased
Haus et al. [53]	12 weeks(1 hour, 5days per week)	Aerobic(85% of HRmax)	16 subjects	Human	Female/male	65 ± 1	Visfatin decreased

Table 5: Comparison of this study with some other published papers in this field.

In the present study, the mean changes of insulin resistance significantly decreased only in resistance group compared to aerobic. Some studies cited exercise can improve insulin sensitivity in postmenopausal diabetic [38,43]. Effects of exercise on insulin sensitivity are attributed to glucose transporter system activation, depletion of muscle and liver glycogen and skeletal muscle blood flow increase [44]. Although studies about the intensity of exercise on insulin sensitivity are varied; some express that the most effective exercise intensity can improve insulin resistance and some argue even moderate and light physical activity is enough [19,45]. In this case, our result is comparable with those studies that shown the high intensity and type of exercise maybe the cause of insulin reduction [46,47].

On lipid profile

In the combined group; LDL index was significantly decreased compared to resistance while Cho index in the resistance group compared to aerobic and combined groups was decreased significantly. Although HDL and TG indicators were improved in each of the three patient groups following training, but no significant decrease were reported- may be due to similar changes between the groups. Research related to lipid profile in patients with diabetes is associated with various results. Consistent with our findings, Kelly et al. examined the effects of aerobic exercise in patients with DMT2 and reported significant decrease in LDL without significant improvements in triglyceride [48]. Also the present study is comparable with a study by Arora et al. who compared aerobic and resistance training on improving lipid profile in DMT2 patients and concluded the better effect of resistance training on improving Cho index compared to aerobic exercises [49].

On visfatin

Even though according to our results, visfatin level decreased in both aerobic and combined groups and increased in resistance group, but the mean changes between groups was equal. As a result, no significant differences between PVL in all groups were observed. Up to day, visfatin performance is not fully understood; however it can be effective in glucose homeostasis, but on the other hand may promote obesity [50]. Some studies have found a positive association between visfatin with BMI and BF% [51], so it seems that weight loss and improved body composition can reduce visfatin levels in patients with diabetes. However, in our study, weight loss was not enough to lead to a significant reduction in visfatin levels. Haider et al. showed that PVL increasing can be prevented by insulin injections in DMT2 patients [6]. Accordingly, insulin reduction may compensate with visfatin concentration changes. So, it is likely that exercise with insulin-like effects lead to reduce visfatin levels. Jorge et al. in their study stated; increasing PVL followed by 12 weeks of aerobic, resistance and combined training that this increase was associated with no change and no improvement in insulin resistance [19]. In contrast, some studies have pointed out to reduce visfatin plasma associated with insulin resistance following implementation of exercises [52,53]. In the present study, according to the results of multiple regressions, no significant correlation were found between visfatin and insulin resistance. This finding partly rejects the role of visfatin in insulin resistance; however, we cannot express any comment with certainty due to the low number of subjects in the present study.

Relationship between PVL and lipid profile is not yet entirely clear but as regards this hormone is secreted by adipose tissue, so changes in lipid metabolism and lipid profile may affect the PVL [54]. In the current study, among the lipid profile parameters only LDL and Cho had a significant decrease that these changes were significant in the combined and resistance groups, respectively. According to our results from multiple regression analysis there was a significant positive correlation between visfatin and parameters of LDL and Cho, so reducing LDL and Cho levels in post-test status can affect visfatin reduction. One study from Brema et al. also indicated correlation between PVL changes and changes in BF% and blood HDL level in diabetic patients [55,56].

Conclusion

In general, our results confirmed many interests of exercises in DMT2 patients and proved that exercise can favorably affect the glycemic, lipid profile and anthropometric indices. Overall, each type of exercises had a positive impact on certain parameters in each patient group.

It is notable that no significant differences were observed in mean changes of Hb A1c and mean visfatin changes between the groups of this study, that is likely due to limitations of our working; the low number of participants, duration and intensity of exercises are probable contributing factors in these findings. Indeed, our results derived from only one medical center with a small sample size which included merely women with DMT2, so we suggest additional longitudinal studies with

more participants in both sexes and different study settings to evaluate relationship between visfatin and insulin resistance in women with DMT2.

In general, our results showed the positive effects of all three types of exercise on the glycemic index, anthropometric and lipid profile in women with type 2 diabetes. However, there was no significant difference in the mean changes of hemoglobin A1c and visfatin. Its possible reasons could include the small sample size (subjects in this study included only a small sample of women with diabetes from only one medical center), duration and intensity of exercises. So, it is recommended to confirm the role of insulin-like visfatin and its relationship with insulin resistance, further studies be conducted with more subjects in both sexes.

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